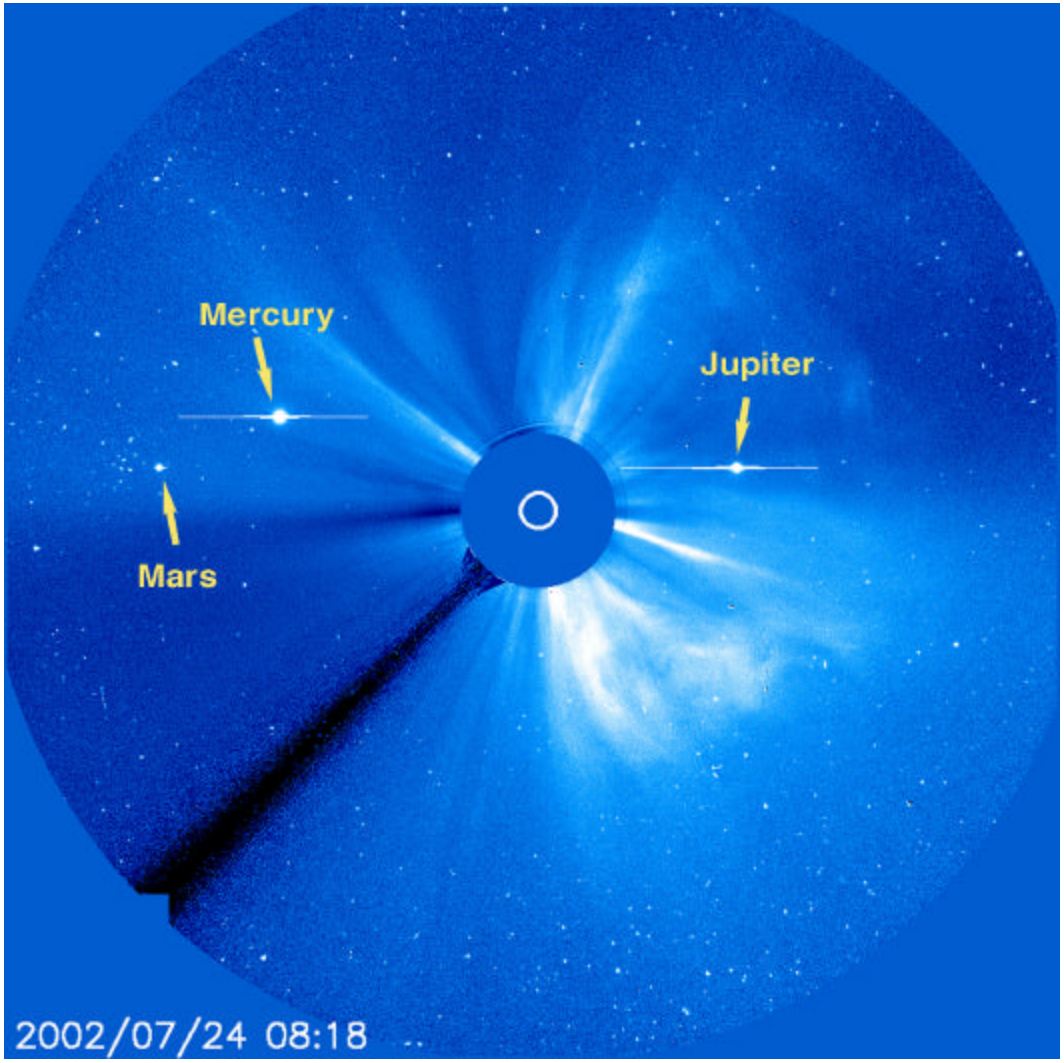
The Sun - Earth Connections Division



THE Sun-Earth Connection Division

Program Overview

4 September 2002

Richard Fisher
Director, Code SS
NASA HQ

SEC Program Elements

- **Strategic Plans**
  - **2002 is an important year for SEC Strategic Planning**
- **Operating Missions**
  - **Currently 14 operating missions support the research program**
- **Program Mission Lines**
  - **There are two SEC mission lines:**
    - **Solar Terrestrial Probes (STP)**
    - **Living With a Star (LWS)**
- **Cross-Divisional Mission Lines**
  - **There are two mission lines operated for the benefit of the Office of Space Sciences:**
    - **Explorer Mission Line**
    - **New Millennium Technology Mission Line**
- **Supporting Research and Technology Program**

Strategic Planning for SEC

2002 is a significant year for the SEC Division

- **National Academy of Sciences:**

"The Sun to the Earth – and Beyond An Integrated Strategy for Solar and Space Physics, 2003-2013"

Report of the NRC's Solar and Space Physics Survey Committee, L.J. Lanzerotti and J.L. Burch, 6 August 2002

- **Sun-Earth Connection Advisory Subcommittee Roadmap Document (Reviewed every two years)**

Report to the Space Science Advisory Committee, 4 September 2002

- **Office of Space Sciences Strategic Plan**

Anticipated November 2002

- **NRC and SECAS committees validate LWS and STP flight mission scientific goals and priority**

SEC Division Scientific Objectives

SEC Strategic Goal: ***Understand how the Sun, heliosphere, and the planets are connected in a single system.***

- **Explore the fundamental physical processes of plasma systems in the universe**

- **Understand the changing flow of energy & matter throughout the sun, heliosphere, and planetary environments**

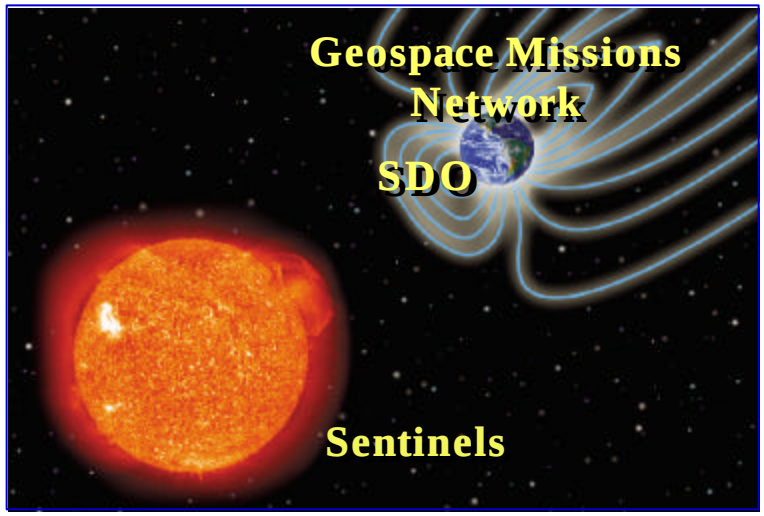
- **Define the origins and societal impacts of variability in the Sun-Earth Connection**

SEC Flight Missions

- **Operating Missions**
  - **Distant Heliospheric missions**
    - VOYAGER, ULYSSES
  - **L1 *in situ* sensing missions**
    - ACE, SOHO (solar wind instruments), and WIND (2003)
  - **Solar remote sensing missions**
    - SOHO, TRACE, and RHESSI
  - **Magnetospheric/Ionospheric missions**
    - CLUSTER, FAST, GEOTAIL, IMAGE, POLAR, and SAMPEX
  - **Earth's Mesosphere**
    - TIMED

——— Indicates prime mission phase

SEC Flight Mission Programs



Current LWS Missions

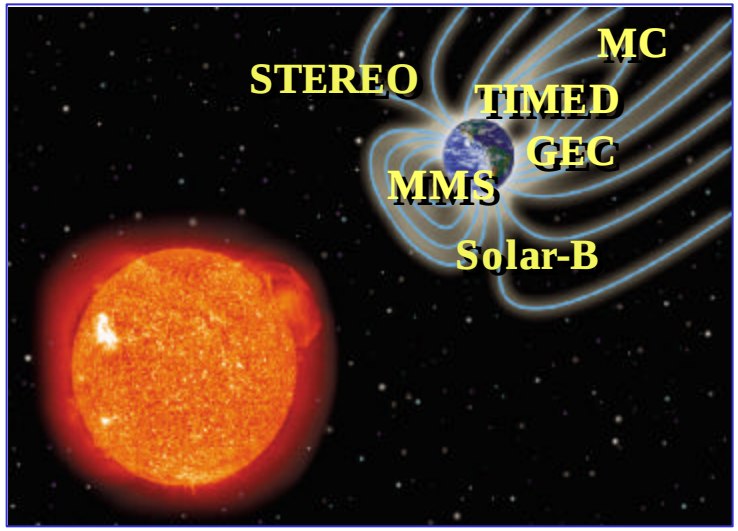
- **Living With a Star (LWS)**
  - Missions to characterize the Sun-Earth System behavior and identify the critical physics that link parts of the system
  - Program Elements Include:

    1) A Space Weather Research Network

    2) Theory, Modeling, & Data Analysis Program

    3) Space Environment Testbeds (SETs)

- **Solar Terrestrial Probes (STP)**
  - Missions with focused investigations to explore specific scientific research questions



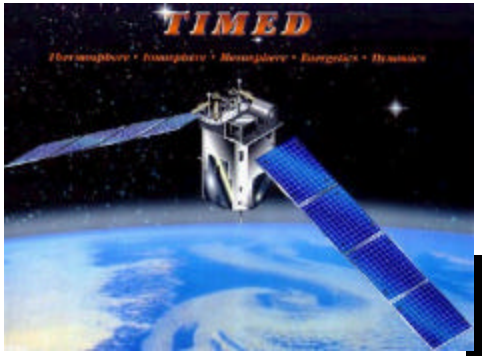
Present STP Missions

Solar Terrestrial Probes (STP) Program

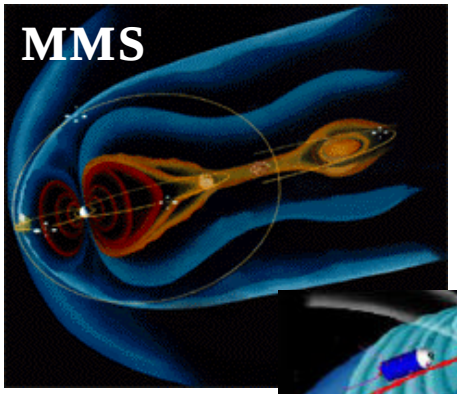
- **A strategic element of the Sun-Earth Connection Science Roadmap**
- **A continuous sequence of flexible missions designed for the sustained study of critical aspects of the connected Sun-Earth system**
- **A creative blend of in-situ and remote sensing observations, from multiple platforms, addressing focused science objectives**
- **The community-selected initial Solar Terrestrial Probes are:**
  - **Thermosphere Ionosphere Mesosphere Energetics Dynamics (TIMED)**

    (Launched 12/7/01)
  - **Solar-B**
  - **Solar-Terrestrial Relations Observatory (STEREO)**
  - **Magnetospheric Multiscale (MMS)**
  - **Global Electrodynamic Connections (GEC)**
  - **Magnetospheric Constellation (MC)**

Solar Terrestrial Probes (STP)

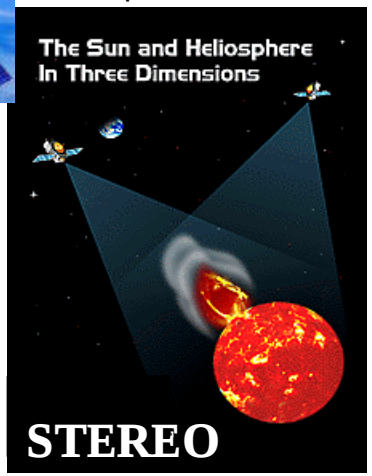


Determine basic structure and understand energy balance of mesosphere, lower thermosphere, ionosphere



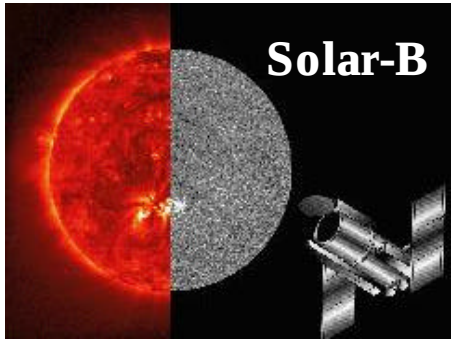
Understand fundamental plasma processes of reconnection, acceleration and turbulence

Understand origin, evolution, and propagation of CME's



Understand plasma interactions with the atmosphere

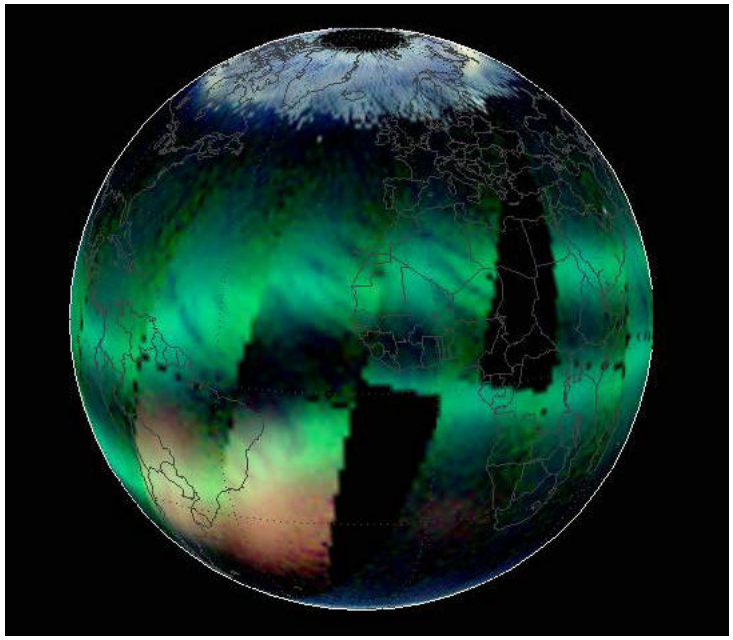
Understand creation and destruction of solar magnetic field



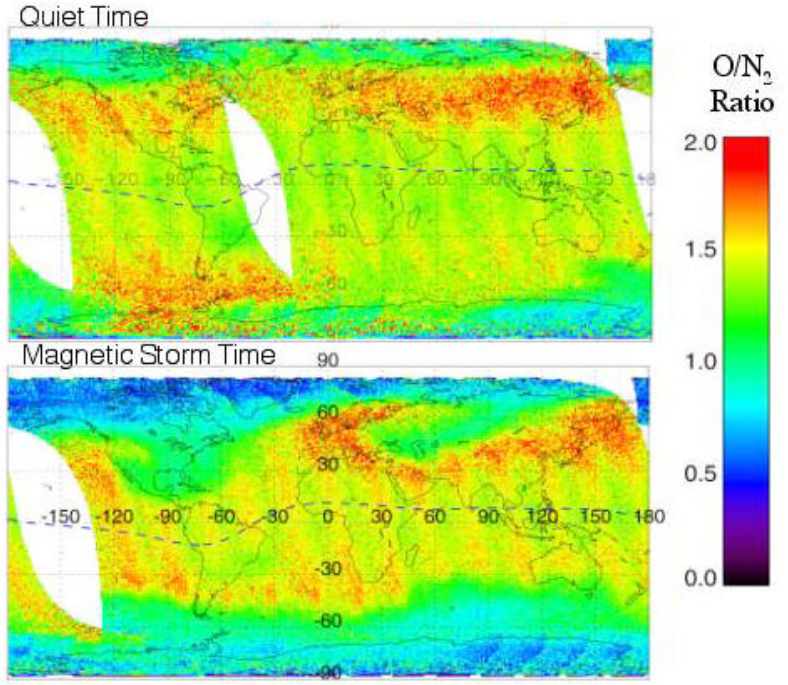
Understand processes that control the dynamic state and energy flow of the magnetosphere

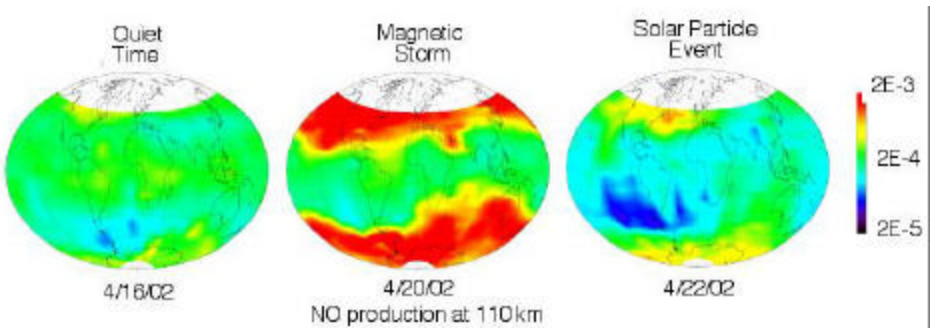
SEC NEWS (1)

- **TIMED Operational**
  - Alteration of the mesosphere as a consequence of Solar and Earth's magnetospheric activity.



First GUVI Image of Global Distribution of Mesospheric Bubbles





SEC LWS MISSIONS -I

- **Solar Dynamics Observatory**
  - Three missions selected in August 2002 for phase A development
- **Geospace Missions**
  - **Geospace Mission Definition Team identifies the Ionospheric-Termospheric Mapper and Radiation Belt Mapper Missions as highest priority.**
- **Space Environment Testbeds**
  - **Draft NRA written and circulated**
- **Targeted Research and Technology**
  - **TRT goals and priorities team selected and announced (J.Gosling, chair)**
- **Solar Probe Mission**
  - **Midterm Applied Physics Laboratory Team report (August 2002)**

Living With A Star (LWS) Program

- A strategic element of the Sun-Earth Connection Science Roadmap

- Utilizes a systems approach to develop the scientific understanding necessary to effectively address those aspects of the connected Sun-Earth system that directly affect life and society

- Implemented by a sequence of inter-related missions

- The initial LWS strategic missions are:
  - –Solar Dynamics Observatory (SDO)
  - –Geospace Missions Network
  - –Sentinels
  - –Solar Probe

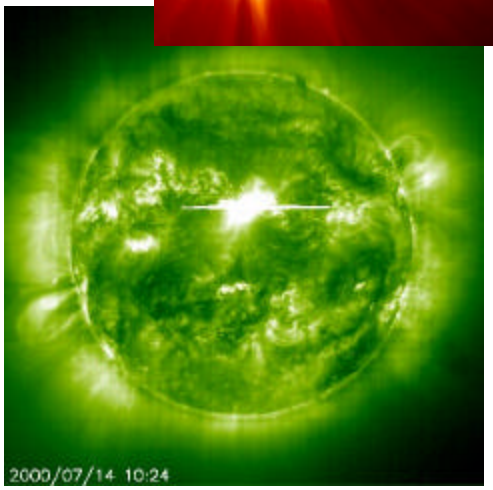
The Solar Dynamics Observatory (SDO)

Goal

Observe the Sun's dynamics to increase understanding of the nature and sources of solar variations

Focus areas

- *Origin, structure and variability of the Sun's magnetic field*
- *Relationships between the Sun's magnetic field and solar mass and energy releases*



The Solar Dynamics Observatory (SDO)

- *Status*
  - *Pre-mission concept is complete*
    - *Geosynchronous orbit*
    - *3-axis stabilized spacecraft*
    - *5-year primary lifetime*
    - *Complement of solar-pointed instruments selected via AO*
  - *GSFC in-house implementation approach approved by Code S*
  - *Instrument AO released in January 2002*
    - *Instrument selection completed in August 2002*
- *Launch – August 2007*

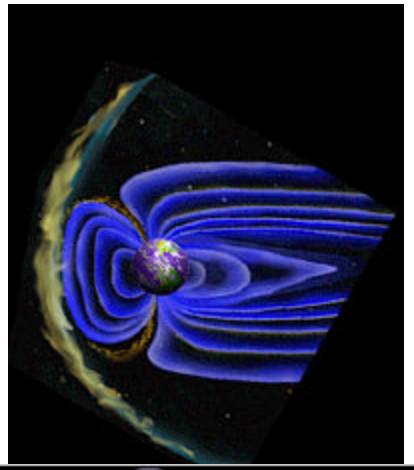
The Geospace Missions Network

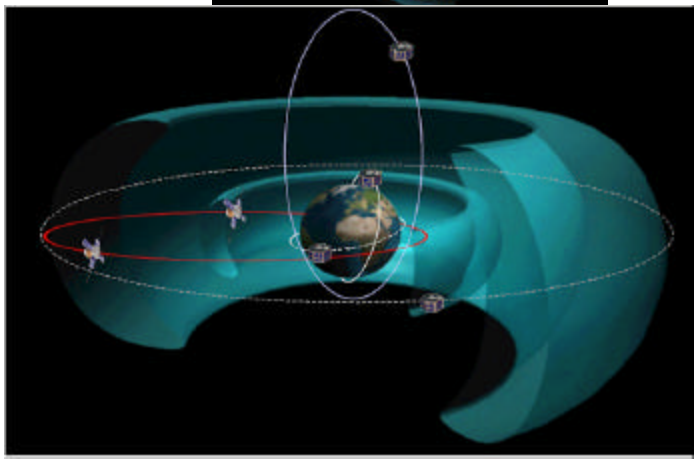
Goal

Increase scientific understanding of how the Earth's ionosphere and magnetosphere respond to changes due to solar variability

Focus areas

- Radiation belts
  - Origin and dynamics of the radiation belts
  - Evolution of the radiation belts during magnetic storms
- Ionosphere
  - Effects of changes in ionizing radiation on the ionosphere
  - Variations of neutral density and drag, plasma density and drifts, *scintillations, auroras, and winds*





The Geospace Missions Network

- *Status*
  - *May 2000 pre-formulation study defined two missions*
    - *Radiation Belt Mappers (RBM)*
    - *Ionospheric Mappers (IM)*
    - *Initial costing grater than allocated funding for Geospace Missions, therefore new approach was required*
  - *Network science and mission architecture currently under study by Geospace Mission Definition Team (GMDT)*
    - *Science and technical support being provided by GSFC and APL*
  - *GMDT report submitted in August 2002*

- *Launch - notional IM launch 2008, notional RBM launch 2010.*

The Solar Sentinel Missions

Goal

Understand the transition and evolution of eruptions and flares from the Sun to the Earth's magnetosphere

Focus areas

- *Determine the structure and long-term climatic variations of the ambient solar wind in the inner heliosphere*
- *Determine how geo-effective solar wind structures propagate and evolve in the inner heliosphere*
- *Determine what solar dynamic processes are responsible for the release of geo-effective events*
- *Determine how and where energetic particles are released and accelerated*

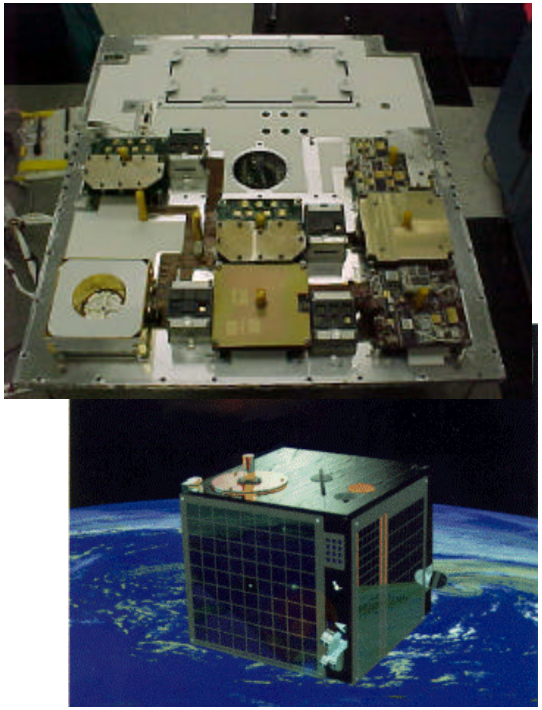
Status

- *Mission architecture under study with International Living With a Star (ILWS) partners*
- *Launch – TBD*

Living With A Star
Space Environment Testbeds (SET)

Objective

Improve the engineering approach to accommodation and/or mitigation of the effects of solar variability on spacecraft design & operations

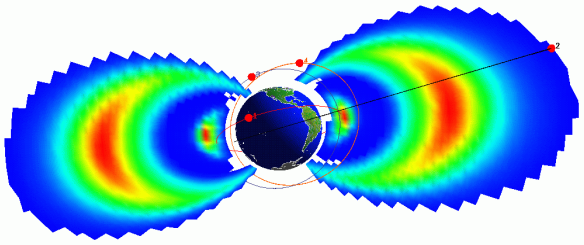


Approach

- Collect data in space to validate the performance of new technologies & instruments for LWS science missions
- Collect data in space to validate new & existing ground test protocols for the effects of solar variability on emerging technologies
- Develop & validate engineering environment models, tools, & databases for spacecraft design & operations

Scope

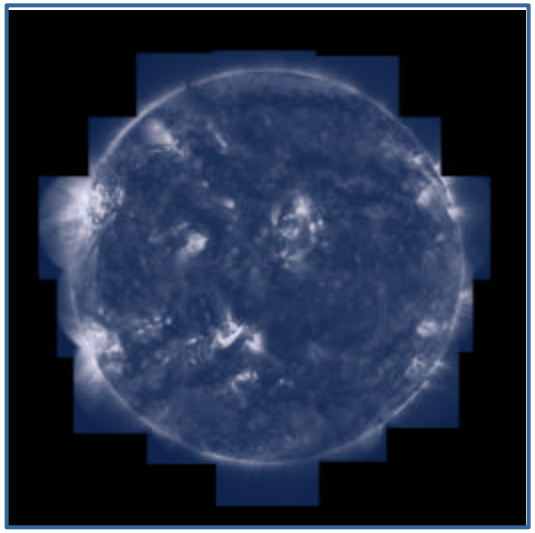
- Spacecraft hardware & design/operations tools whose performance changes with solar variability
- Use flights of opportunity approach



Living With A Star, Theory, Modeling And Data Analysis (TMDA)

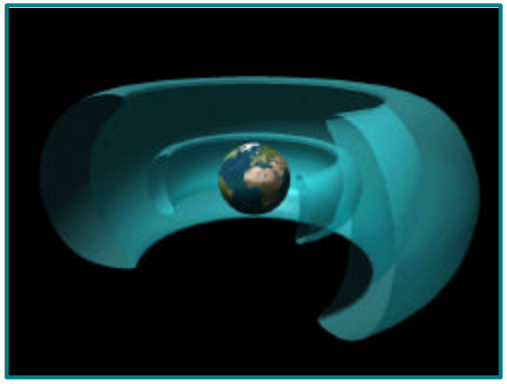
Objective

Perform ground-based research to refine the understanding of space weather & the role of solar variability in terrestrial climate change



Approach

- *Develop new instrument techniques, models, and concepts for investigating solar and geospace disturbances*
- *Improve scientific knowledge of space environment conditions and variations over the solar cycle*
- *Improve understanding of the effects of solar variability on long-term climate change*
- *Improve the environment specification models & predictive capability*
- *Issue of yearly Research Opportunities in Space Sciences (ROSS) Announcement of Opportunity*



Solar Probe

Status

- *JPL developed implementation plan during FY01*
- *FY02 President's Budget cancelled mission*
- *FY02 Congressional Budget Funded mission in FY02 only ($3M)*
  - *Mission assigned to APL*
  - *Mid-term progress report August 2002*
  - *Final study report with cost analysis due December 2002*

Cross-Divisional Flight Mission Lines

- SEC manages two Cross-Divisional Flight Mission Programs
- New Millennium missions develop and flight validate innovative technology
- Explorer Missions target at augmentation of Code S program with SMEX and MIDEX missions.
- Both New Millennium and Explorer missions proposed from SEC experimenters have been selected for investigation.

New Millinium Technology

- **ST - 5**

ST- 5 is a technology development mission aimed at flight validation of new spacecraft techniques required for the development of mullti-spacecraft missions such as the STP Mag Con mission.

ST-5 project management held the CDR for the project in late winter 2002.

Launch Date not currently identified.

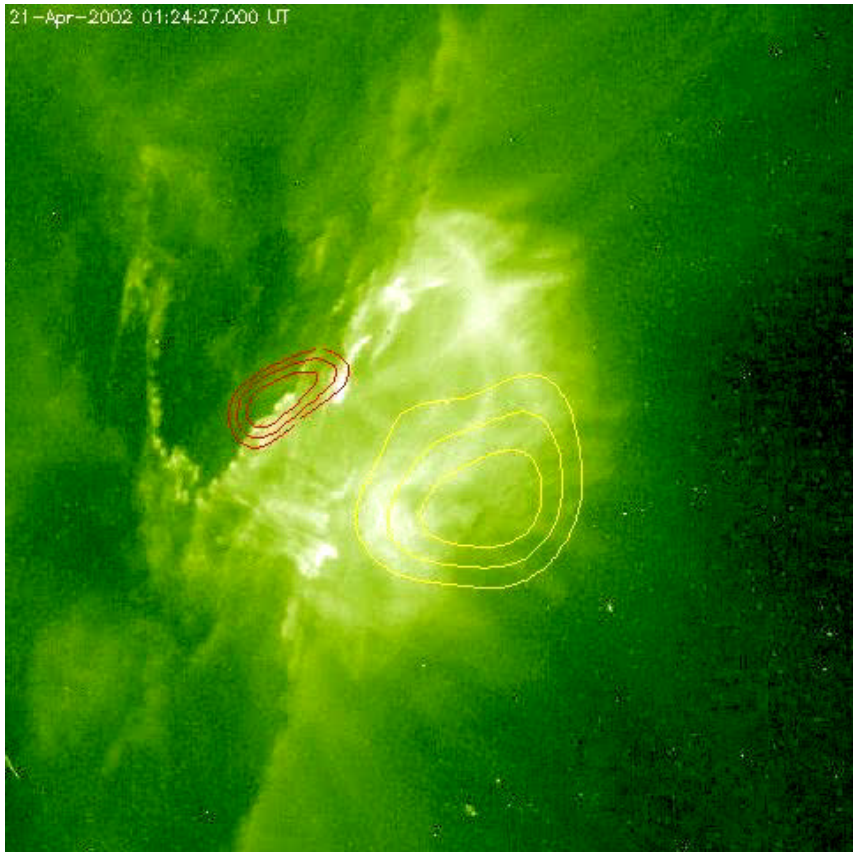
SEC Explorer Missions

- **Two MoOs in development**
  - **CINDI -** Ionospheric experiment on C/NOFS) satellite
  - **TWINS-** Two-s/c ENA imager experiment

- **Two SEC MIDEX phase A competitors**
  - THEMIS- magnetic substorm investigation
  - ASCE **-** solar coronal investigation
  - Downselect expected winter 2003
- **AIM - SMEX Phase A Study**
  - Polar mesospheric cloud investigation

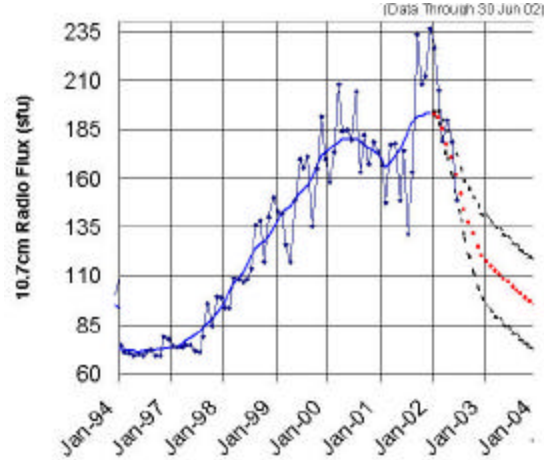
SEC NEWS (2)

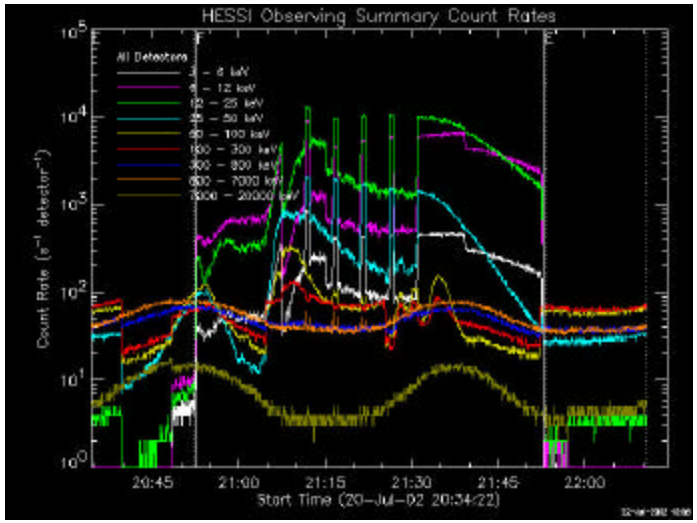
- **RHESSI Operational**
  - First 4-D observations of solar flare events



TRACE - RHESSI Composite Image of EUV and X-ray Images of Flare Activity

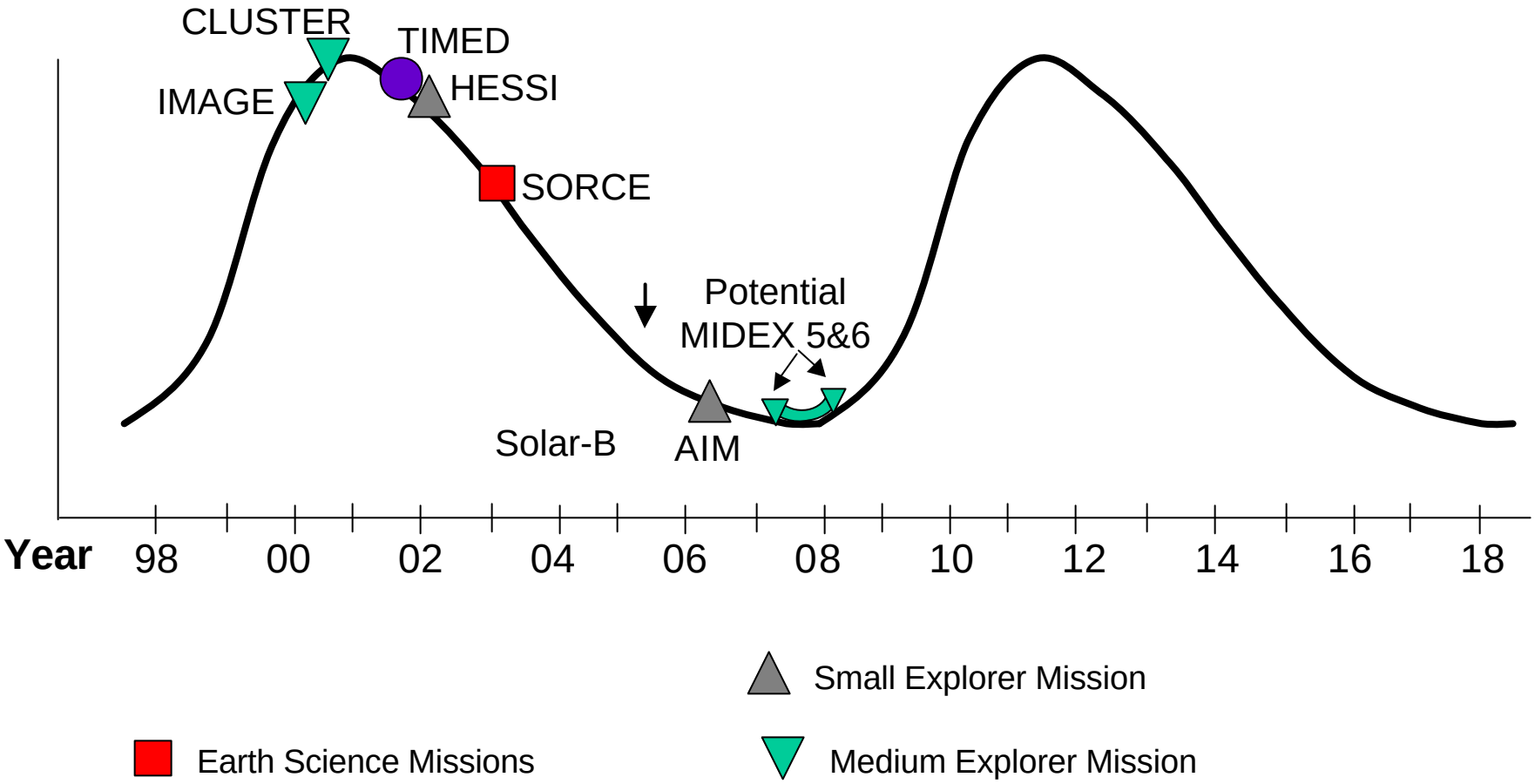
F10.7 flux demonstrates high level of solar activity at present



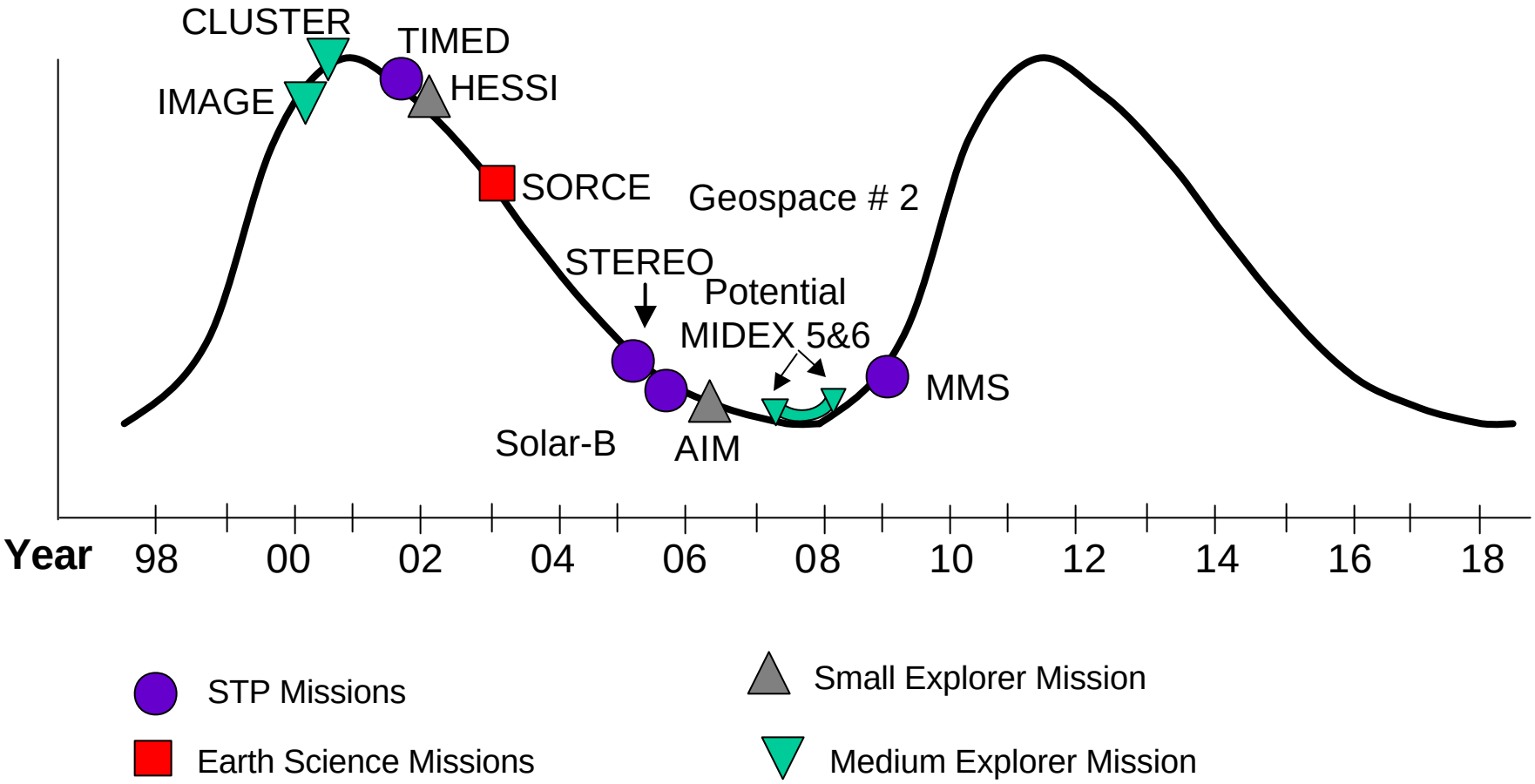


RHESSI quick look data of firstgamma-ray flare 20 July 2002

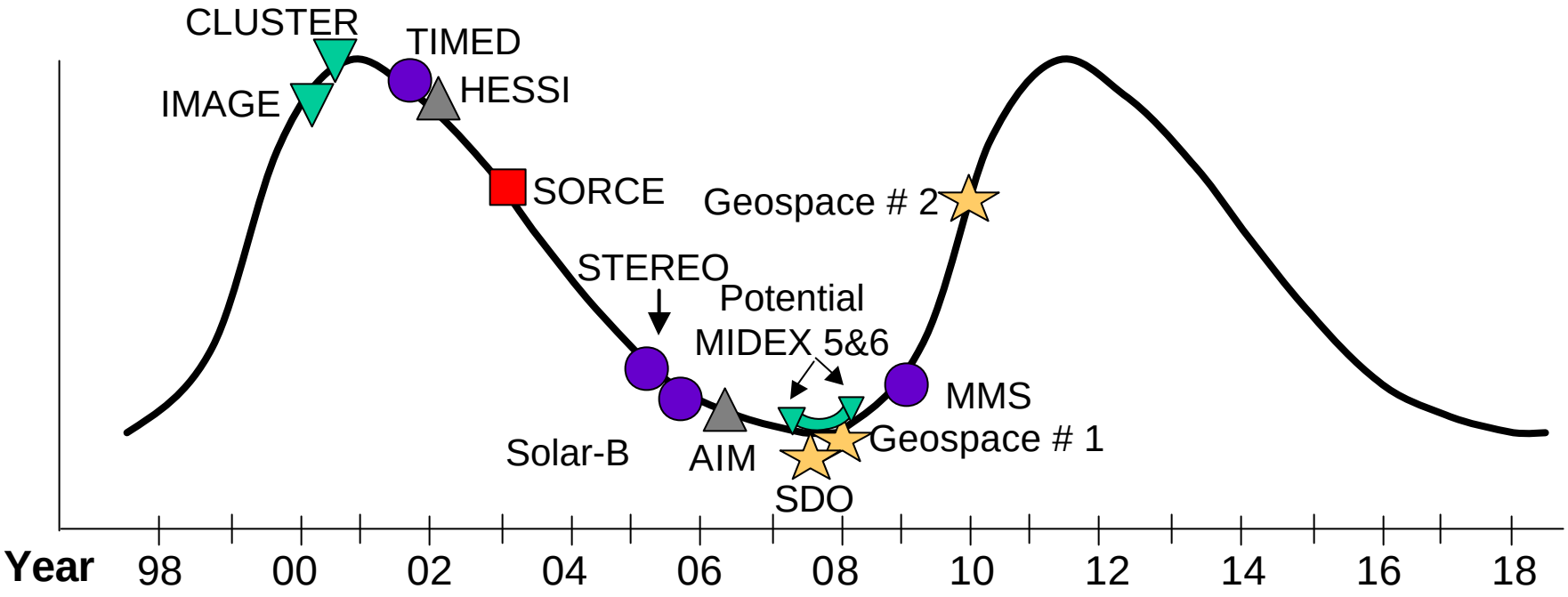
SEC Strategic Plan



SEC Strategic Plan



SEC Strategic Plan



STP Missions

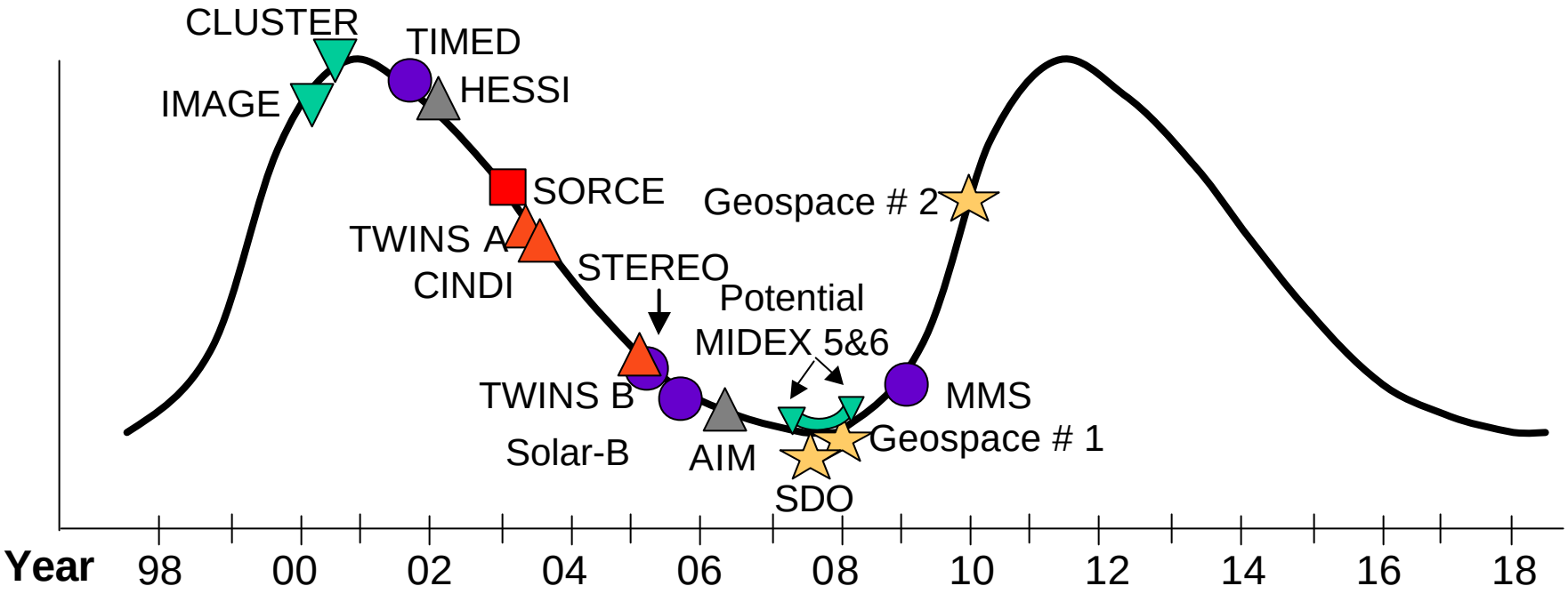
Earth Science Missions

LWS Missions

Small Explorer Mission

Medium Explorer Mission

SEC Strategic Plan



STP Missions

Small Explorer Mission

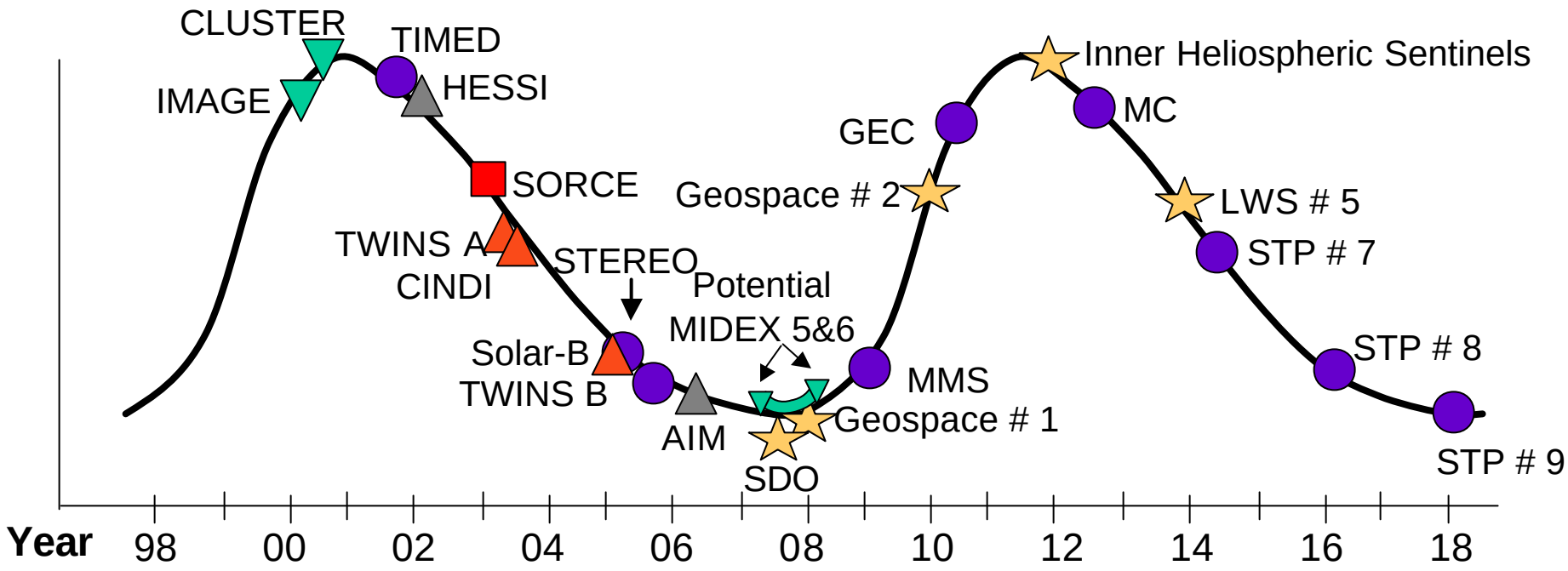
Earth Science Missions

Medium Explorer Mission

LWS Missions

Explorer Mission of Opportunity

SEC Strategic Plan



STP Missions

Earth Science Missions

Small Explorer Mission

Medium Explorer Mission

LWS Missions

Explorer Mission of Opportunity

Summary of NASA SEC Program

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

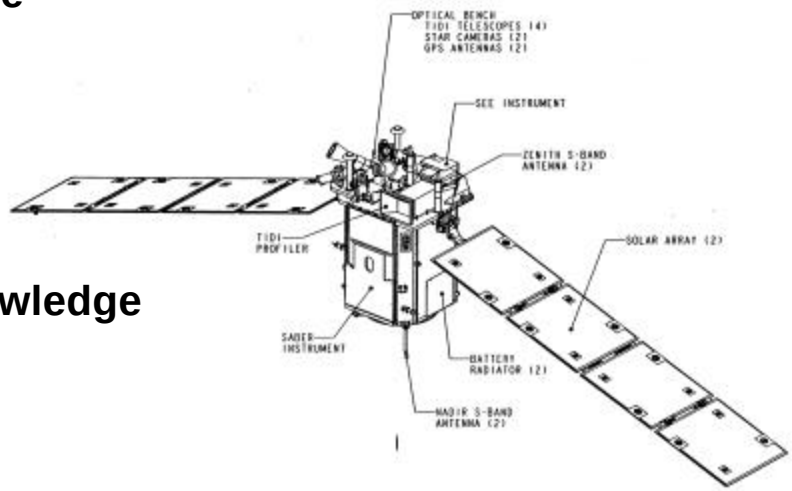
- New Stgrategic Plan 2002
- Two Flight Mission Development Lines
  - STP
  - LWS
- Two Cross-Division Flight Mission Lines
  - NMP
  - Explorer
- Schedule:
  - 2005 STEREO
    - Solar-B
  - 2007 SDO
  - 2008 ITM
  - 2010 RBM

End

TIMED Spacecraft/Mission Description

Spacecraft:

- Four Scientific Instruments, 100% Duty Cycle
- Fully Redundant S/C
- 587 Kgm
- 406 Watts Orbital Average
- 5 Gigabit Storage
- 4 Megabit Downlink
- Three Axis Stabilized, .5° Control, .03° Knowledge
- Onboard GPS Navigation
- Increased Autonomy



Mission:

- Two Years Mission Operations, Four Years Data Analysis
- Mission Operations Center, Mission Data Center, and Primary Ground Station at APL
- Payload Operations Centers Located at P.I. Facilities Fully control Instruments
- Delta II Dual Payload Attach fitting (DPAF) Launch with Jason-1

LWS Program Development

- **ILWS first meeting**
  - Scheduled 4-6 Sept 2002
  - 27 invitations/ 14 responses to date
  - Agenda to include issues of collegial/contributory participation in ILWS
  - Report to IAGC 12-13 Sept (Moscow)
- **LWS US-Partnership Meeting**
  - Scheduled 13 August 2002, Wash. D.C.
  - NASA, DOD, NOAA, NSF, and FAA representation anticipated
  - Agenda includes “Gap Assessment” for U.S. program in space weather

SEC LWS MISSIONS

- **Missions in Development**
  - **Solar Dynamics Observatory (SDO)**
    - AO released, payload selection anticipated 8/2002
- **LWS Mission Definition**
  - **Geospace LWS missions**
    - GMDT report drafted, anticipated delivery 9/2002
    - Mission assignment anticipated fall 2002
    - AO release for GEOSPACE1 01/2003
- **TMDA**
  - TMDA-DT formed 08/2002, J. Gosling chair.